Centre for Independent Experts

Independent Experts Report of the Center of Independent Experts (CIE) review of the Pacific cod - Bering Sea & Aleutian Islands and Gulf of Alaska stock assessment models conducted for the Alaska Fisheries Science Center (AFSC), 14 March - 18 March 2011.

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Executive Summary

This document is the individual CIE Reviewer report of the review of the Pacific cod (Bering Sea & Aleutian Islands and Gulf of Alaska) stock assessment models for the Alaska Fisheries Science Center (AFSC). It represents the views of the independent reviewer, Dr Chris Darby.

The review was conducted as an open meeting at the Alaska Fisheries Science Center, in Seattle, Washington, from 14-18 March 2011. All of the meetings Terms of Reference were addressed. Documents were made available prior to the meeting; areas that required clarification, or, where it was considered that additional analysis was needed, were raised during the meeting by the review team and additional results, presentations and documents provided subsequently.

The ability, attitude, and coordinated approach presented by the AFSC are all considered to be of a very high scientific standard with best scientific practice being followed in the data collection, collation and assessment process. Some areas of "weakness" were identified where there is a requirement for more information and analysis, either by the presenters themselves, by the stock assessor as a result of model results, or by the review team. It is clear that the researchers are aware of many of the issues and are addressing them in their research programs.

The cod assessment models are considered highly developed (to the point of being over developed) and the model structures, although appropriate for the data available and for the estimation of the fishery and population metrics, are creaking; the number of parameters estimated is at the limit of the available information.

The fitting of the models at such borderline parameterisations places a heavy workload on the assessor especially when numerous sensitivity runs are required each year. It is suggested that benchmark meetings, at which assessment model formulations are fully reviewed and agreed are followed by freezing of the structure for a few years, are introduced to give the assessor breathing space for model development. In the longer term, the management process will benefit from the stress relief.

It is of slight concern that the current management strategy has resulted in a decline to B35%, despite assessments indicating that the reference exploitation rate has been well below the management target for the stock. Consequently, full support for the research into a full simulation evaluation is suggested in which a coupled assessment model and management process is conducted in order to test the robustness of the procedures and rules in place.

Background

The Center of Independent Experts (CIE) review of the Pacific cod (Bering Sea & Aleutian Islands and Gulf of Alaska) stock assessment models for the Alaska Fisheries Science Center (AFSC) was conducted at the Alaska Fisheries Center, Seattle from the 14 March - 18 March 2011.

This document is the individual CIE reviewer report of the meeting; it represents the views of the independent reviewer, Dr Chris Darby.

The review, chaired by Anne Hollowed for the AFSC, was conducted as an open meeting with presentations to the review team and interested participants, followed by questions and discussions. It was attended by a representative from industry processors during the first day, scientists involved in the data gathering, assessment and management process and SSC and Plan Team members; all provided input to the discussions. The review meeting had good background support from the AFSC staff prior to and during the meeting with a web site for distribution of documentation and analysis, as required.

Assessment reports and management advice documents from the previous two years and the Stock Synthesis assessment program manuals and technical documentation were distributed and reviewed prior to the meeting. Documents on the data collection process, observer coverage and protocols, survey protocols and analysis were provided to the review team at the meeting. A list of documents is provided in Appendix 1. Areas that required clarification, or where it was considered that additional sensitivity analysis would help, were raised by the reviewers at the meeting and discussed with the data collection team or the assessor after exploratory runs of the model had completed.

During the meeting the review panel was provided with presentations on the species and stock biology, the collection of catch data by the observer program, trawl surveys, fitting of the stock assessment model and management process. Details were also provided in presentations as to where research programs are going to be taken in the future indicating a strong drive to improve the quality and utility of the data collection and analysis.

Presentations were well prepared and appropriate for each subject. Sufficient time was allowed for each topic and to clarify issues that arose. Comments from the industry observers, especially on the observer process and quality of catch information, were sought during the meeting and these made a valuable contribution to the review process. Additional work, when requested by the reviewers, was completed in time for further discussions at the meeting or run during the evenings for the next day. Due to the amount of time required to achieve an acceptable solution using the iterative process required for fitting of the Stock synthesis model for this stock a number of runs were left with the stock assessor at the end of the meeting and these were submitted during the following week.

General

The AFSC staff presenting to the review team and with whom the discussions occurred are all considered to be working to a very high scientific standard with best scientific practice being followed in the data collection, collation and assessment process. Studies and analysis are based on good scientific and statistical science and supported by peer reviewed research and assessment reports. Some problem areas were identified in the data collection and collation, especially with respect to ageing and stock identity. It is clear that the researchers conducting the data collection and subsequent analysis are aware of the issues and are addressing them in their ongoing research programmes.

Several areas of potential weakness in the assessment and reporting process were identified that could be addressed to ease pressures, especially on the workload of the assessor.

The stock assessment framework

The assessment process is reliant on the Stock Synthesis program. Modifications can be requested from the program author, but there is a heavy dependency on that one source for coding and testing of alterations.

It is assumed that once a new program has been received it is tested by the assessment authors to the extent that it can reproduce the previous assessments results with the same data. In addition if not already available a test data set with known parameter estimates and uncertainty that would be used to benchmark new versions should be considered.

The complexity of the program makes it difficult to compare the assessment results with runs using other assessment programs, however, this should be attempted particularly with simpler models, e.g. survey based, using alternative assessors to ease the burden on the current one. This will provide feedback as to the uncertainty in the assessment process resulting from model structure.

Given the data structures available for the assessment there are few if any alternative models for the final assessment. Given the high dependency on the one system, a custom built approach could be developed (as a research project?) to provide an alternative; alternatively a test data set that reproduces the characteristics of the cod stocks should be considered (as is being constructed by Teresa A'mar, CIE Presentation J) as a priority so that evaluation of the current model formulations and changes to them can be examined against known solutions.

The stock assessment staff

As with the Bering Sea pollock assessment reviewed in June 2010 there is a heavy reliance on a key stock assessor for the production and presentation of the assessment and output for the two stocks. This reliance on one person could present problems and can result in an excessive workload at key times, especially if the stocks decline towards the SSB threshold at which severe restrictions are imposed.

If, as has been suggested, the Bering Sea and Aleutian Islands assessment region is divided into two stocks, based on the genetic studies outlined by Ingrid Spies (CIE presentation I), then the workload of the key assessor will become impractical.

The Assessment process

Part of the heavy workload results from the requirement for the assessor to run a series of exploratory models as suggested by members of the public, reviewers etc. prior to each annual meeting. This is considered excessive and can place undue pressure on the assessment team whilst also introducing a perception of uncertainty/instability with respect to the assessment process. The majority of run alterations result in only minor variations to the relative status of the stocks.

ICES has introduced a system of benchmarking of its assessments in which assessment models are reviewed at a scientific meeting which agrees the best model structure and data sources available at that time. The structure and data sources are then frozen, apart from the addition of new data each year, and the assessment run as an update for a fixed number of years - unless evidence is presented of the need for a new review. At the end of the agreed time frame the process is repeated, the biology of the stock, available data and potential models are investigated, information sources agreed and the cycle restarted.

The advantage of the ICES process is that it allows:

1) periods of stability in which the best science available to date is used for the evaluation and estimates of stock metrics are stable from year to year
2) the assessor time to develop models for each stock without the pressure of the timing of the advisory cycle;
3) the development and testing of harvest control rules which incorporate estimation uncertainty but not changes to the model structure each year;

Such a cycle would allow the stock assessors to concentrate on each stock in alternate years (for instance) so that development can be evaluated in a more relaxed time frame compared the current system which is trying to deliver the best science for two (potentially three) stocks simultaneously.

Stock assessment reporting

One way in which the workload could be reduced is to separate the information within the assessment report into two documents; currently the report has a split personality. It tries to present the technical aspects of the collection of the new data available each year from the surveys and observer program, the diagnostics from the model fit to the updated data and also provide a non-technical summary of the output for managers and the SAFE report.

The report does not provide the full set of details required for a full and detailed review of the model. This is especially the case when a variety of runs have been evaluated following suggestions from the members of the public and management team. It cannot summarize the build up to the final assessment, sensitivity analysis and consequences for management without being too large to produce each year.

An approach that has been used elsewhere is the production of an annual technical report that can be used by reviewers and a summary report for managers that can be updated with new information each year if it is available and relevant. A lot of what is required for the technical report can be automated.

Reporting assessment uncertainty

As part of the review process it was very difficult to determine the degree of variation that has occurred in the estimated stock and management metrics between the consecutive assessments. ICES and others produce two forms of quality control diagrams, as part of their annual reporting, that give insight into the variation from year to year in the perception of stock status:

1) Retrospective analysis - the final agreed model structure fitted, stepping backwards in time, removing a year of data each time
2) Quality control diagrams – showing the results of the final agreed assessment from each year

The agreed model may change in any year so that 1 and 2 are not the same.

In her presentation to the panel, Teresa A'mar (CIE Presentation J) showed the quality control diagram for the BSAI cod of the form that is required for (2) which are reproduced below. They illustrate how the agreed estimates of spawning biomass and recruitment have changed over time.

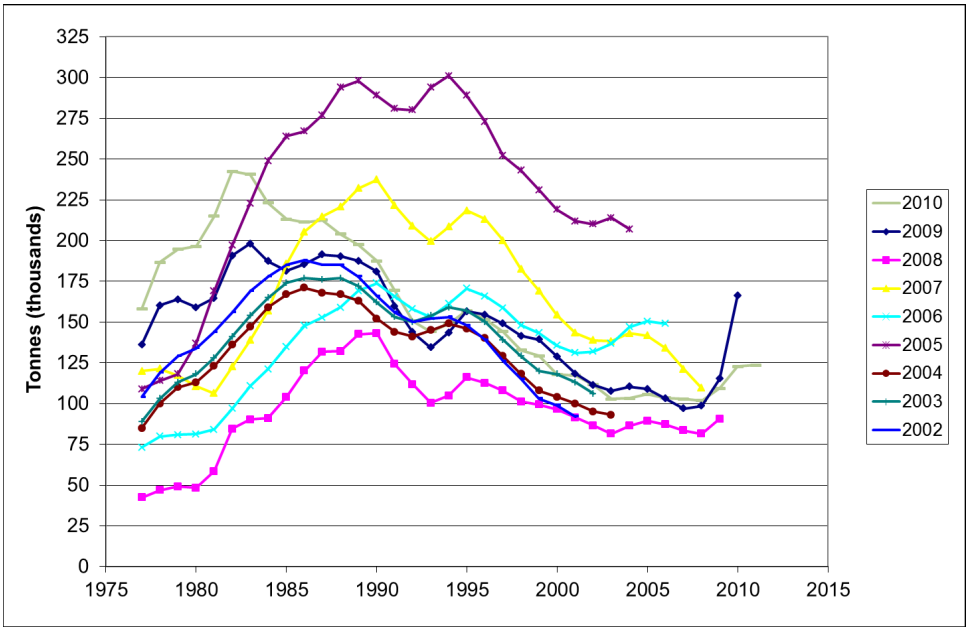


Figure 1. Consecutive assessments of the spawning biomass of BSAI cod as published in the annual SAFE reports (source Teresa A'mar, CIE Presentation J).

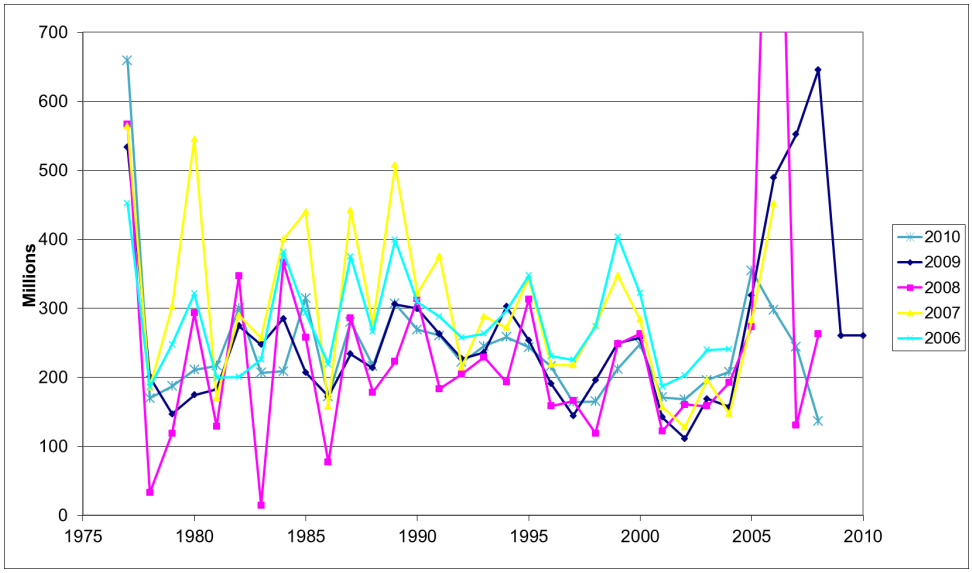


Figure 2. Consecutive assessments of the spawning biomass of BSAI cod as published in the annual SAFE reports (source Teresa A'mar, CIE Presentation J)

It is suggested that as part of the reporting process such diagrams and their equivalent on a relative scale (e.g. SSB / SSB25% as that is the scale used for management) be considered.

The CIE reviewer terms of reference

TOR (1). Use of age data, including:

a. Use of age composition data
b. Use of mean-size-at-age data
c. Use of ageing bias as an estimated parameter
d. External estimation of between-individual variability in size at age.

TOR (1a). Use of age composition data

The sampling by observers for length and age is controlled by protocols established to prevent autocorrelation in samples from influencing the results. Studies of the information provided by the sampling programme (Barbeaux et al 2005) were examined by this author during the review of the pollock assessment in June 2010 and again for this review. The procedures for collection of otoliths and length samples are considered appropriate.

Presentations on the problems associated with the ageing of the cod otoliths by Anderl (CIE Presentation F) highlighted the deterioration in the agreement between age readers after age 8~9, as shown in the figure below taken from that presentation.

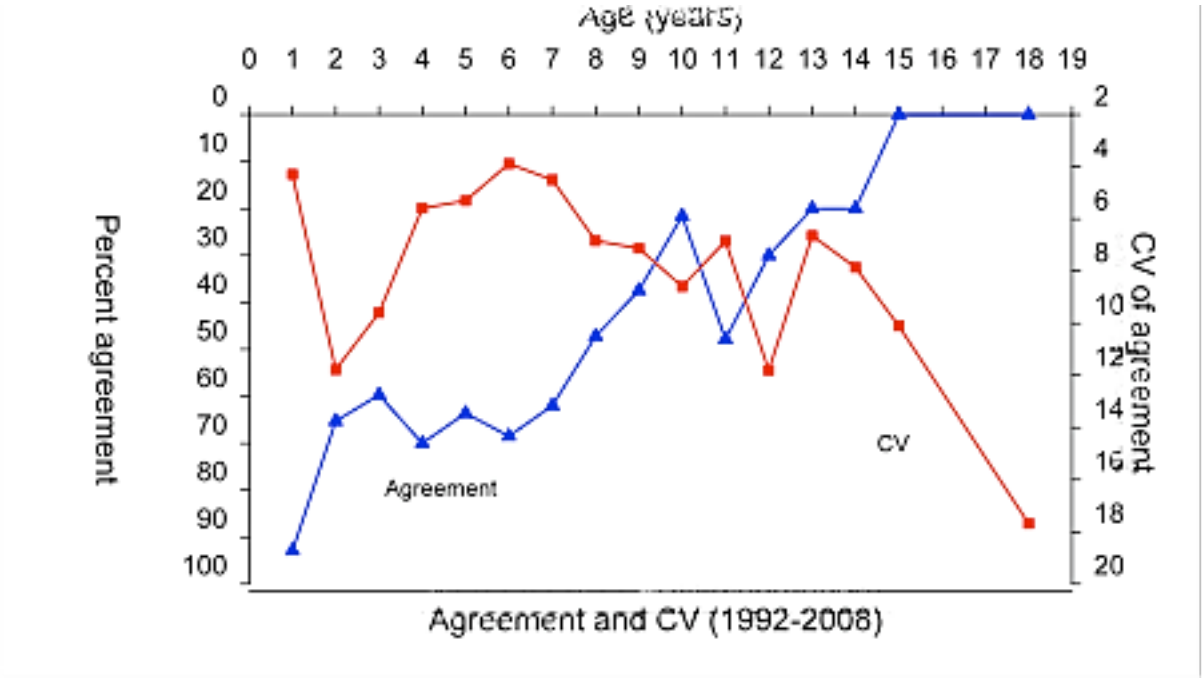


Figure 1. Observer agreement in the cod ageing programme

The externally estimated ageing error is incorporated within the fit of the model as a c,v. on the age compositions - but the values used are not detailed within the assessment report to determine the relative weighting. Consequently the way in which increasing uncertainty at the oldest ages is handled could not be evaluated.

Inclusion of the ageing error is appropriate - given the lack of agreement between readers outlined in the Anderl presentation. Given that:

1) there is information on the error in the reading of the age, based on an agreed standard for determining ages and,
2) there is a known potential bias within the age reading that is being investigated (TOR 1c),

then the inclusion of the age composition data in the model fit is considered appropriate. It is clear that its omission leads to problems due to mismatches in the length distribution modes as shown by the Model C results.

If the research into age reading establishes a new protocol for determining the age of cod that is accepted as the new standard, then one suggestion for reducing the uncertainty inherent in the assessment would be to use otoliths collected from the commercial fishery at regular intervals (e.g. every three years) to augment the survey information. This would require a relatively low increase in sampling levels but would help to stabilize the model estimates from the increased information level.

TOR (1b). Use of mean-size-at-age data

Mean size at age was included within the model to allow the fitting of cohort specific growth. If this model is not used then the data is not required. CIE runs 10 and 11 evaluated the removal of the mean size at age.

As mean size-at-age is derived from the same information as the age composition data (age and length frequency samples), the data are not strictly independent and therefore if it is to be included the correlation with the age composition data should be considered carefully (halving the likelihood component contribution?).

TOR (1c). Use of ageing bias as an estimated parameter

Model fits in previous years have highlighted a potential conflict between the modes in the length distribution, the survey age distributions and the growth model used in the assessment. The presentation on cod ageing by Anderl (CIE Presentation F) and research being conducted into otolith oxygen and carbon isotope distributions by Kastelle et al. (CIE Presentation G), both highlighted that there is a potential bias in some of the age observations due to the deposition of false growth rings and possible edge effects. The work by Kastelle et al. established that for some otoliths there is a difference between the position of the translucent rings used as the basis for ageing and the temperature records deposited within their chemical composition. The otolith chemistry research studies have yet to conclude the extent of any bias in the otolith ring interpretation (too few samples to date) but it will provide an extremely useful validation of the ageing process.

The model fits that estimate bias indicate over-ageing of the otoliths when compared to the modes in the length distributions. The bias estimated by the model will arise partially from the laying down of false rings, as highlighted by the otolith chemistry studies, but could also result from an inappropriate formulation of the growth curve - in terms of either, the use of a single growth curve when variable growth is more appropriate, or a formulation that is not sufficiently flexible to model the specific seasonal (and regional) characteristics of the length data from the fishery.

One area of concern is the modeling of bias as a single value starting at age 2 and which is modeled as a parameter with a symmetric distribution. If the bias results from the formation of false rings then

would not bias increase with age as the opportunity to form false rings increases? In addition, the study by Kastelle et al. indicated that many of the otolith ages were read correctly for the remainder age was over-estimated – this would seem to imply an asymmetric bias.

TOR (1d). External estimation of between-individual variability in size at age

Presentations to the review established that estimation of between-individual variability in size at age could not be achieved internally (Thompson, CIE Presentations A,K,L). Models 5 and 6 fitted to the BSAI cod and 5 fitted to the GOA cod both estimate variances for the standard deviation of mean length at age that are significantly larger than the majority of the observations.

The method by which the external estimates are obtained and entered as external estimates in the fitted models is considered appropriate at this stage in the model development. However, an observation on the figures reproduced below from Thompson (CIE presentation L) is that there appears to be curvature in the data at increasing size at age. Is this an artifact of temporal changes in the linear relationship such that plotting them together appears curvilinear or is a more complex relationship between the standard deviation and mean length?

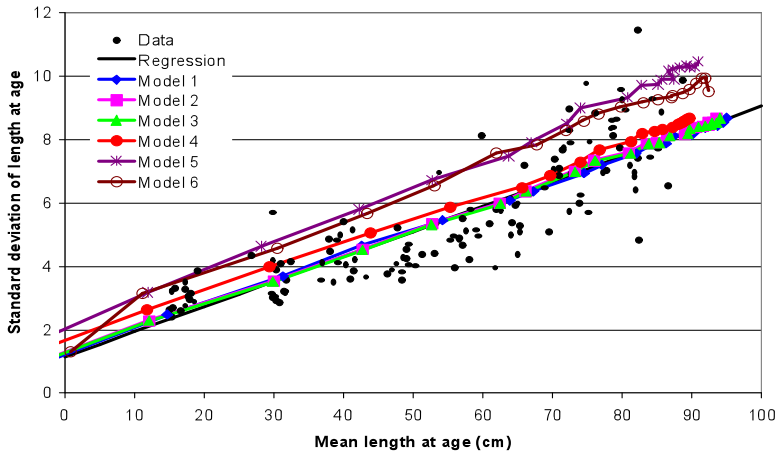


Figure 2a. Conditional variability in length (BSAI cod)

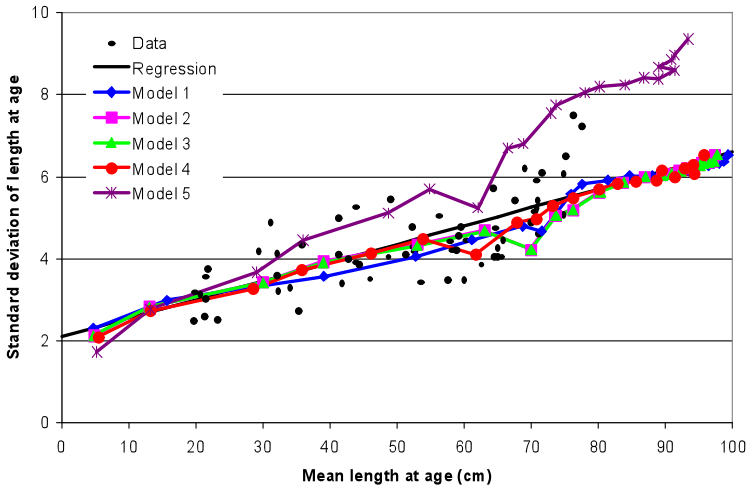


Figure 2b. Conditional variability in length (GOA cod)

TOR (2). Data partitioning/binning, including:

a. Catch data partitioned by year, season, and gear
b. Size composition data partitioned by year, season, gear, and 1-cm size intervals
c. Age composition data partitioned by year, season, and gear.

TOR (2a.) Catch data partitioned by year, season, and gear

Information on the catch history and the composition of catches and discards is presented within the assessment document.

CIE presentations B (J. Mondragon) and C (P. Nelson) to the review team described the current observer program including the selection of boats and hauls to sample. Cod catch data are collated by area from observer estimates of retained and discarded catch; historic catch levels were more uncertain due to lower observer coverage. For boats greater than 125ft, the sampling protocol specifies the selection of hauls to be sampled, the approach to sampling each haul and the number of length and age samples to take from each sample. Currently, only 30% of boats between 60 and 124ft are sampled, with the vessel selecting which trips are monitored; boats less than 60 ft are not sampled. Catches from unobserved trips are obtained from landings reports - this will change with the introduction of a new scheme which will provide full coverage. The observer sampling scheme is designed to prevent autocorrelation in samples of length and age data when sampled from hauls within the same area or on the same trip and is appropriate for its task.

Following an analysis of the seasonal structure of the amounts of catch landed by month the optimal seasonal structure for the catch model was considered to comprise 5 seasons for BSAI and GOA cod; differing by stock. Three selectivity periods are defined for each gear type which overlap the catch seasons. The reasoning underlying the approach and the analysis to identify the seasonal components is considered appropriate. Clearly there is a seasonal component to the landings resulting from fishery practices or the seasonal availability of the cod to the gears and this will be reflected in catchability/selectivity estimates and therefore should be incorporated in the model structure in the fit to the length distributions.

CIE runs 11 and 12 explored simplifying the structure to a generic gear for each of the 5 catch seasons. This approach may make the model simpler but by collapsing the length distributions from differing gears into a generic composition it is assumed that the combined "gear" has relatively constant selection from year to year. The catch component figure below – from the R4SS output for the BSAI and GOA fisheries illustrates that this is not the case, for example in the BSAI fishery, the trawl gear dominates catches in the early time period with a decline in the second half of the year from 1990 and a concurrent increase in pot and long line components catches from ~1995. Some of the changes in proportions – especially around the late 1980's cannot be assumed to be smooth transitions between gears. Changes in the GOA fishery have been equally if not more variable. Consequently, I would have doubts about the utility of a collapsed model in which length compositions are mixed across gears in proportions that have change markedly and quickly during the time series.

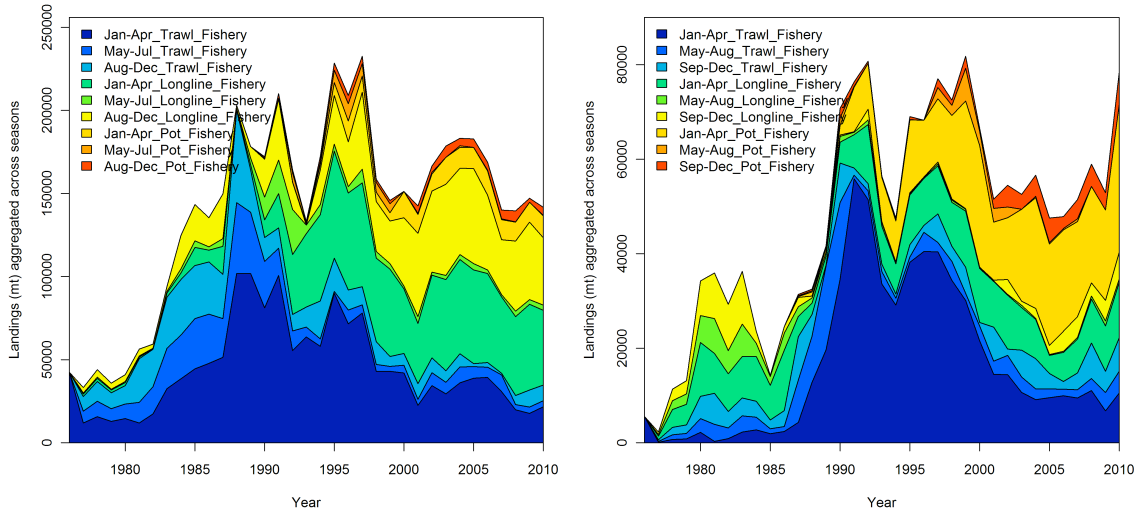


Figure 3. Catch components by gear type and gear selection period for the BSAI fishery (left) and GOA fishery (right).

TOR (2b). Size composition data partitioned by year, season, gear and 1-cm size intervals

The finer 1-cm bin structure for the size composition data was introduced as a refinement to allow the analysis of length to correspond to the scale at which the data was collected. In the range of lengths for which large amounts of data are collected from the fishery by gear this is considered appropriate. However, at the smallest and largest sizes finer binning introduces large numbers of zeroes in the length distributions. Dynamic binning was examined at the meeting in runs GOA9 and CIE9 and appeared to be the way forward. Questions were raised during the review about how SS3 treats sample sizes when combining bins, and this should be investigated.

TOR (2c). Age composition data partitioned by year, season, and gear.

Commercial fishery age composition data for a single year was used in earlier models for BSAI and GOA cod but not in recent assessments. Use of a single year's data can be problematic in terms of weighting and therefore its omission is considered appropriate. Previously within TOR(1a) it was suggested that if the research into age reading establishes a new standard ageing procedure then one approach to reducing the uncertainty inherent in the assessment would be to use otoliths collected from the fishery at regular intervals (e.g. every three years) to augment the survey ageing information. This would require a relatively low increase in sampling levels but would help to stabilize the model estimates from the increased information available for the assessment.

The trawl survey for the BSAI cod stock is separated into two periods from 1981 and earlier (three years), and 1982 onwards as a result of a gear change; the data from 1979 - 1981 do not include age structure information. The early period data would not be expected to influence current stock size estimates to any significant degree, the fit of the size composition curves is relatively poor for the survey, and therefore there would seem to be little point in retaining it within the model fit.

The trawl survey for GOA cod is separated by length into sub-27 and 27-plus components, which is carried out to help the model resolve a missing mode in the length frequency data for age 2 cod.

"Missing" 2-year old fish are also modeled within the EBS pollock assessment in which they are observed in the water column and not available to the trawl gear. A similar lack of availability as a result of spatial separation may be occurring for the GOA cod. The way in which the size composition is modeled is an artifact of the restriction to the SS program, this is not ideal; it would be better to have an assessment model that allows allow for this, as the current solution requires extra parameters to fit the model.

TOR (3). Functional form of the length-at-age relationship and estimating the parameters thereof

Discussions with the assessment author reviewed the potential for using a more flexible form of the length-to-age growth curve than that used currently, the von Bertalanffy growth model. One form that had been suggested and that is available in the Stock Synthesis program is the Richard's growth formulation – a flexible formulation with a subset of curves that include the von Bertalanffy formulation. Three runs of the SS program were conducted in which the growth Richard's model was fitted - CIE1 and CIE2 and GOA2. For the BSAI cod the model fitted with the new growth formulations had a worse fit to the data for the GOA cod (which did not require the initial length to be constrained) there was a marked improvement in the model fit. The Richard's function is more flexible but there are problems in its fitting, potentially implying that it is not flexible enough at the youngest ages / sizes. It would be beneficial, given the potential link to bias estimation, to evaluate other functions if the Stock Synthesis author can be encouraged to code them.

This is an area of analysis that will require continual revision until the model stabilises. The growth model links the length distribution modes with the cohorts in the population on an annual and seasonal scale. Changes to the age reading standards, estimation of ageing bias and also the seasonal split of the length data will all result in differing estimates of growth patterns.

TOR (4). Number and functional form of selectivity curves estimated, including assumptions regarding which selectivity curves should be forced to exhibit asymptotic behavior.

Assumptions about the asymptotic form of selectivity at age or length are common in stock assessments - arguments about the "correct" functional form and how to apply it, are just as common.

The procedure used for the selection of the fleets with asymptotic selection was described in the presentation by Thompson (CIE presentation K). The methodology is unique and it specifies the selectivity of the fleets relative to the fleets that catch the greatest proportion of large fish. The method will result in those fleets with the highest catch rates of large fish having similar asymptotic selectivity but it is not clear that this implies asymptotic selection with respect to the population. The procedure ranks similar gear types within a season differently for the BSAI and GOA cod stocks, which may be spatial effects, but does seem surprising.

This is clearly an area for which there is a need for more analysis, as is the case for this constraint in the majority of stock assessments. In general targeted trawl fisheries are assumed to have asymptotic selection, unless there are specific spatial or temporal reasons for assuming otherwise. If possible more information from tagging studies or linkages to assumptions made in other assessments with known selectivity for large fish by the same gears is required.

Variation in selectivity in time is modelled by fitting blocks of selectivity parameters for each fleet and survey; this was examined in the model fits GOA3 and CIE3. For both stocks there appears to be a drift in time for some fleets (e.g., the GOA May – Aug and Sep – Dec trawl fleets) and some with no difference between the blocks (e.g., all of the GOA pot fleets).

Comparisons with the base model fits indicate improved diagnostics in the models fitted with the block structure - indicating the need for modelling changes in time. However, it is not clear if the transition points between blocks are appropriate and in some cases the variation in the selection, especially at the largest sizes, could result from fitting to noise. Where there is evidence of a drift in selection parameters in time, a time series approach should be considered (similar to that used for the pollock assessment) and for those fleets which do not show significant change in time, a constant selection model should be adopted in order to remove as many selection parameters as possible.

TOR (5). Fixing the trawl survey catchability coefficient for the recent portion of the time series such that the average product of catchability and selectivity across the 60-81 cm size range equals the point estimate obtained by Nichol et al. (2007).

The study by Nichol et al. (2007) provides a linkage between cod behavior and survey catchability that is not used within any other assessments of which I am aware. Cod of size 60 -81cm were shown using data storage tags to be available to the survey gear for a restricted proportion of time due to the movement in the water column at depths above the survey head rope. Consequently, model catchability for the two assessment trawl surveys is constrained at the value that sets the average (weighted by numbers at length) of the product of catchability and selectivity for the 60-81 cm size range equal to the point estimate of 0.47 for BSAI cod and 0.92 for GOA cod (higher head rope on the survey) obtained by Nichol et al. (2007). Sensitivity analysis CIE7 estimated catchability for BSAI cod resulting in a parameter very close to the fixed value - indicating good agreement.

The assessors and those conducting the study are aware the study that could be improved / enhanced by the addition of additional tagging information as the study had to be restricted to 11 tags that were located on flat sea bed for an extended time period when behavior could be examined – rather than moving on slope edges. Adding to the data base of tags and releases in a larger area will enhance amount of information available for fitting the assessment model.

It was a concern that a large proportion of the tags were returned very soon after the study started, which would imply a much higher exploitation rate than that estimated by the assessment. This was discussed with those conducting the experiment who explained that the tags were returned by vessels fishing in the area of the tagging very soon after release. It would be valuable to attempt to guesstimate the mortality rates of the tags in time in order to ensure that localized high exploitation rates are not resulting in problems. If possible, it would be useful to piggy-back tagging studies, using conventional tags, onto the data storage tag studies to enable gear selection to be estimated especially at the largest fish sizes.

TOR (6). Fixing the natural mortality rate at the value corresponding to Jensen's (1996) Equation 7

Thompson (CIE Presentations K, L) presented the way in which M has been addressed during the development of the two cod stock assessments. Internal estimation of M was attempted in analysis CIE8. The model fit was considerably worse indicating that there is not sufficient information within

the current structure to develop alternative values. The comments in this section apply to both the GOA and BSAI cod assessments

The assessment model currently fixes the value of natural mortality at a value derived externally and based on Jensen's (1996) equation linking natural mortality to the age at maturity; for GOA cod the value used is 0.38, for BSAI cod 0.34 - fixed for all ages and years within the model. Natural mortality estimates have been estimated in previous assessments and were found to be close to those used currently. Therefore the current fixed values are considered appropriate.

It is likely that natural mortality varies (decreases) with age/size as has been estimated using multi-species models for the North Sea by ICES working groups; however until such studies are available for the Pacific cod the single value is considered appropriate to the current state of knowledge for the stocks and the information contributing to their assessments.

Confounding of the internally estimated natural mortality values at age or size with fleet and survey catchability and selection is well studied. Consequently fixing the value at the best "estimate" with a known provenance allows the basis to be explained to managers, examination of the sensitivity of the stock status to the value and alternative management scenarios explored within simulation studies.

As more information/studies becomes available, the externally estimated value can be updated; but this should follow a full review of the model fits and consequences for management in a benchmark meeting and not within the annual assessment process that is conducted each year.

TOR (7). Input sample sizes for size composition and age composition data, and input log-scale standard deviations for survey abundance data.

Early in the review it was highlighted by one of the panel members that the survey variance calculations for the abundance indices were not based on the formulation for random stratified surveys.

Input sample sizes for size composition are derived from a complex bootstrap procedure which is carried out prior to the data being included within the assessment. Sample sizes are then re-scaled so that the average value across all samples is 300. Input sample sizes for the age composition multinomial distributions are derived by scaling the actual number of otoliths read each year such that the average of the input sample sizes was equal to 300.

The rescaling to an average of 300 balances the weighting given to the information from the age and the gear and season size composition sources. This makes the assumption that data collected for ages and size compositions are of equal quality / value in the fitted model. Data collected within a data source, for instance size distributions from a fleet and season, maintain their relative weight within that information set; this is appropriate.

Effective sample sizes are calculated within the model and can then be compared with the input sample sizes to determine how well the model was fitting the relevant set. In many of the size distribution fits the effective sample size was estimated to be very high (a good fit) to simple, dome shaped distributions, but low (poor fit) for multi modal distributions. If iterative fitting of the model using reweighting according to effective sample size is used, it is possible that multi modal length distributions resulting from incoming recruitment year classes at the smaller sizes could be down-weighted at the expense of simpler size composition distributions. Similarly fleets that have a very restricted selection range and simple distribution pattern such as the pot fishery would be given a very high weighting at the expense of those with a broader range that encompasses a number of modes from different year classes. This option was explored between assessments CIE11 and CIE12 – the fit of the model to the simpler age structure of the combined commercial fleets in each season dominated

the model fit and the survey size distributions with more modes were considerably down-weighted within the final model.

TOR (8). Allowing for annual variability in trawl survey selectivity

Presentation to the review team (CIE Presentations D (B. Lauth) and E (M. Wilkins)) described the Bering Sea Shelf and Gulf of Alaska bottom trawl surveys, covering their history, design, standardization, catch characteristics, the measurement and effect of environment and future developments.

The bottom trawl surveys are designed to provide data on 20 species for which there is a good time series of sampling from the area. The gear design changed in 1982 with no inter-calibration. The BSAI survey included additional stations for crab samples from 1987 and the survey design has been constant since 1988. Each year a survey report is produced detailing catch results, environmental conditions. Indices are calculated at age per unit swept area based on survey strata.

The surveys design is standardised as far as possible in terms of the trawl gear used, the time and method of deployment, the vessels used to conduct the survey and the sampling procedures. There may be variation in the availability of cod to the survey as a result of environmental change. Studies have established that the spatial distribution of catch rates is related to the distribution of bottom water temperature in the year of the survey. The stratified design should cope with this change but it would provide an interesting PhD to analyse the potential effects of the changes.

Given the standardization of the survey it is surprising that the models are allowing for changes to survey selectivity, at the youngest sizes/ages, which the survey design is attempting to minimize. IT may be that the models are fitting to noise.

TOR (9). Setting the input standard deviation of log-scale recruitment (σR) equal to the standard deviation of the estimated log-scale recruitment deviations

I have little experience of this and other reviewers will comment; however, as with the iterative re-weighting using effective sample size, discussed under TOR(7) re-weighting of this form can lead to domination of assessments by particular constraints or model components and if used without caution often leads to misleading model fits.

TOR (10). Use of survey data and non-use of fishery CPUE data in model fitting

The exclusion of fishery CPUE data from model fits is common practice. Unless standardized the datasets can be:

1) representative of localized concentrations of the stock at particular times of year
2) affected by gear improvements changing catchability
3) altered by management actions, market and fuel prices

The current assessment fits the commercial CPUE data without using it in the objective function. This provides illustrative trends for comparison with the model results and is considered appropriate. The

problem that will be encountered is explaining why the trends may differ if affected by the factors listed

Other considerations from the review

The Jitters

This affliction affects those conducting the stock assessment and those reviewing it.

Following the fitting of the assessment model there is currently a lack of confidence in the final output in terms of whether the model has achieved the global minimum for the fit. A process of "jittering" - starting the model in differing states and evaluating whether it converges to solutions that have higher likelihoods is used to finish the fitting. This takes time (as the model can be slow to converge) which then prevents real time evaluations and sensitivity analyses, such as those trialed at the CIE review, because one is never sure if the results are final until the jittering process is complete.

The need for such a time consuming process results from the model structure pushing the number of estimated parameters to the edge of what is estimable; the models are or are close to being over-parameterised. The problem affects the review, the development time that the assessor can spend on testing and evaluating the model and the quality control and sensitivity analysis that can be applied.

Following the CIE review the team left the assessor jittering. The agreed runs were transmitted the following week and could then be evaluated; however even then only 25 jitters were trialed for each model. During the meeting a retrospective run for each cod assessment was carried out. However, because of the time taken to jitter each backwards step in time the process could not be completed.

There is a trade-off between the number of parameters fitted and the practicality of the fitting in terms of the time available for development, review and reporting to management. The stock assessments and the assessor would benefit from reducing the parameterisation accepting that there will be uncertainty in model estimates and developing management procedures that evaluate and allow for that uncertainty. The management plan evaluations described by Teresa A'mar (CIE Presentation J) could form the basis for such a change but they will be extremely difficult for such a complex, slow, model.

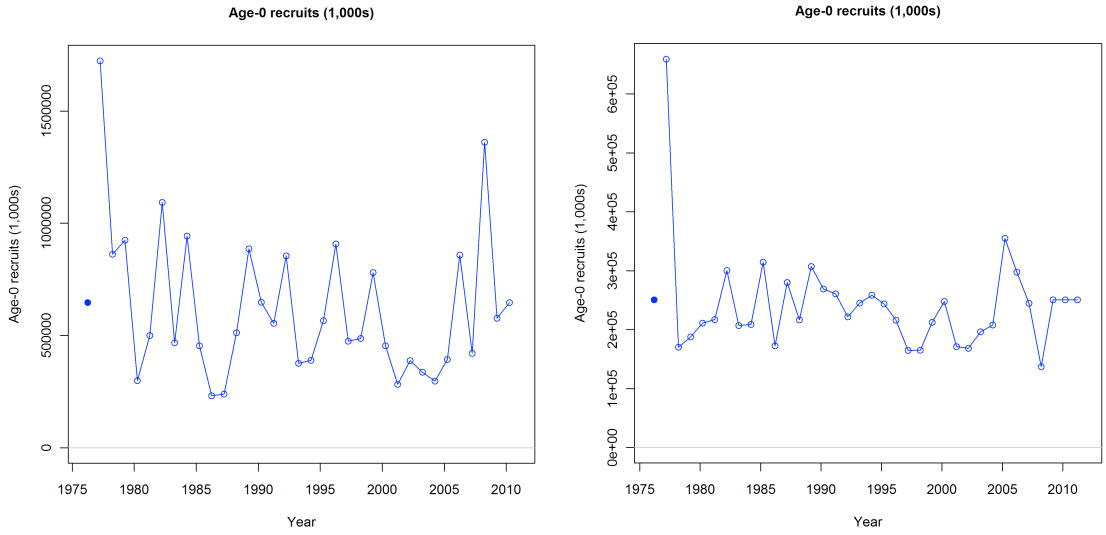
The cod harvest strategy used by the North Pacific Fishery Management Council

A presentation by Jane Di Cosimo (CIE presentation H) covered the management system within which the two cod stocks harvest strategy is defined and enacted and the assessment and management review process for the stocks.

The harvest strategies for the two cod stocks cod (and for other fish stocks in the region) are constructed from sound theoretical reference levels for fisheries systems assumed to be in equilibrium. Overfishing (F_{OFL}) and upper limit target ($MaxF_{ABC}$) fishing levels have been defined based on a framework which considers the uncertainty of the estimates of stock metrics and the reference levels. A reduction in fishing mortality below $B_{40\%}$ (40% of the estimate of the un-fished level of spawning biomass) is used to reduce exploitation at low stock sizes; the fishery is reduced to a bycatch fishery at $B_{20\%}$ (20% of the un-fished biomass) under ecosystem considerations that allow escapement of prey for sea lions.

A slight concern arises when the above rule is compared to the actual trajectory of relative exploitation rate and resulting biomass that has actually occurred during the assessed time series for the cod stocks as reported within the assessment documents. Apart from the recent years of the time series, fishing mortality has been well below the potential level that could be permitted at $MaxF_{ABC}$, the resulting spawning biomass has remained well above $B_{40\%}$. However, even though the mortality rate has remained well below the target level, following a series of low recruitments to the stock, there was been a decline in SSB to just above B35% for both cod stocks. If fishing mortality had been higher in recent years, at or close to the target values, it might have been expected that the biomass decline would have been more substantial resulting in the B20%. This suggests that although a HCR based on the theoretical equilibrium population structure might be expected to perform well, in reality if fishing at the $MaxF_{ABC}$ had been permitted the current management plan structure could lead to closure of the fishery with greater frequency than would be expected.

The time series of recruitments that led to the declines in SSB at the historic exploitation rates are copied from the assessment results below.



For BSAI cod, five years of poor recruitment with one average year were recorded from 2001. Other sequences of low recruitment occurred from 1985 and 1993, therefore such sequences have occurred before and are likely to again. It is noteworthy that the sequence of recruitment deviations is very similar to that of Bering Sea pollock which has a similar management plan and stock trajectory, suggesting a strong linkage between recruitment and environment rather than stock biomass. GOA cod recruitment exhibits a differing time series pattern of recruitment but with much stronger auto-correlation.

The response of the stock at lower levels of exploitation than defined by the HCR, suggests that the HCR may not robust to auto-correlation resulting from sequences of low recruitment and that, had recent fishing mortality levels been closer to the permissible $MAxF_{ABC}$ values, the consequences for the fishery would have been far more severe.

Similar observations were made for the EBS pollock stock in June 2010 and it is suggested that, if they have not already been conducted in the design of the current HCR, evaluations of the HCR of the form described by Teresa A'mar in (CIE Presentation J) are conducted. Recruitment auto-correlation should be part of the operating model in order to evaluate the performance of the current HCR with recruitment series that approximate the observed series rather than based on random re-sampling from a fitted equilibrium curve.

Management plan evaluation

The presentation by Teresa A'mar (CIE Presentation J) discussed ongoing work to evaluate the management plan used for the cod stocks this should be fully supported. This recommendation is based on a series of observations from the review process:

The first concerns the decrease in stock biomass when the exploitation rate has been low throughout the recent time period in comparison to the potential target levels that could be achieved under the management plan. Fishing mortality has been below the target level in all assessment years, however even though the mortality rate has remained well below the target level, following a series of low recruitment to the stock, there has been a substantial decline in the SSB to B35%. If fishing mortality had been higher in recent years, at or close to the target MaxABC values, it might have been expected that the biomass decline would have been more substantial and the fishery impacted. This suggests that, although a HCR based on the theoretical equilibrium population structure might be expected to perform well, in reality the current structure could lead to closure of the fishery with greater frequency than would be expected.

The second observation is that the cod review raised a number of questions that may not have well defined estimates (e.g. natural mortality levels) but the sensitivity of the model estimates and the outcome of the harvest control rule to their effects could be evaluated and included within modified plans. Some suggestions for the study would be:

1) The sensitivity of the stock and fishery outcomes to autocorrelation in recruitment rather than based on random re-sampling from a fitted equilibrium curve.
2) The assumptions concerning natural mortality.
3) The form of the stock and recruit relationship.
4) The lack of agreement in ageing cod and the impact of bias.
5) The frequency of the trawl survey series in the GOA.

Whilst the study would not a definitive answer to all issues, especially as modeling the cap on total catch in the Bering Sea would is problematic, it would highlight key areas of model and HCR sensitivity that could be addressed by modifications to the rule.

Appendix 1: List of documents

Documents provided prior to the start of the meeting:

The 2009 and 2010 assessments documents for BSAI and GOA Pacific cod stocks:

Chapter 2: Assessment of the Pacific Cod Stock in the Eastern Bering Sea and Aleutian Islands Area. December 2009. Grant G. Thompson, James N. Ianelli and Robert R. Lauth.
Chapter 2: Assessment of the Pacific Cod Stock in the Eastern Bering Sea and Aleutian Islands Area. December 2010. Grant G. Thompson, James N. Ianelli and Robert R. Lauth.
Chapter 2: Assessment of the Pacific Cod Stock in the Gulf of Alaska. December 2009. Grant G. Thompson, James N. Ianelli and Mark E. Wilkins.
Chapter 2: Assessment of the Pacific Cod Stock in the Gulf of Alaska. December 2010. Grant G. Thompson, James N. Ianelli and Mark E. Wilkins.

The Stock Synthesis files:

Corresponding to the final models from last year's assessments (*.ctl, *.dat, *.par, *.ss, and ss3.exe).

Relevant excerpts from the minutes of the December, 2010 and February, 2011 SSC meetings:

Draft Report of the Scientific and Statistical Committee to the North Pacific Fishery Management Council. December 6-8, 2010 (4pp).
Draft Report of the Scientific and Statistical Committee to the North Pacific Fishery Management Council. January 31st-February 2nd, 2011 (2pp).

Relevant excerpts from the minutes of the November, 2010 BSAI Plan Team (BPT), GOA Plan Team (GPT), and Joint Plan Team (JPT) meetings:

Minutes of the Joint Plan Teams for the Groundfish Fisheries of the Gulf of Alaska and Bering Sea Aleutian Islands. November 15-16, 2010 (3pp).
Minutes of the Bering Sea and Aleutian Islands Groundfish Plan Team. November 16-19, 2010 (1pp).
Minutes of the Gulf of Alaska Groundfish Plan Team. November 16-19, 2010 (2pp).

Industry submissions:

Comments on the assessments submitted by Quantitative Resource Assessment LLC, on behalf of the Freezer Longline Coalition (QRA comments, February 20th, 2011, 14pp).

Further materials supplied on request

User Manual for Stock Synthesis. Model Version 3.20 (Updated Jan 21, 2011). Richard D. Methot Jr., NOAA Fisheries, Seattle, WA.

Technical Description of the Stock Synthesis II Assessment Program. Version 1.17, March 2005. Richard D. Methot, NOAA Fisheries, Seattle, WA.

Presentations during the meeting:

A) Description of the pacific cod fishery – Grant Thompson (Fishery_overview.pptx, 13 slides)

B) Catch Data – Jennifer Mondragon (CatchData.pdf, 12 slides)

C) Fisheries Monitoring and Analysis Division. North Pacific Groundfish Observer Program – Patti Nelson (North_Pacific_Observer_Program.ppt, 15 slides)

D) Eastern Bering Sea shelf bottom trawl survey of groundfish and invertebrate resources – Bob Lauth (CIE_TrawlSurvey_EBSPcod.ppt, 38 slides)

E) Pacific Cod: What Bottom Trawl Surveys of the Gulf of Alaska and Aleutian Islands Tell Us – Mark Wilkins (Cod_in_GOA_and_AI_Surveys.ppt, 42 slides)
Supplementary material: AI_distmaps.ppt (11 slides) and GOA_distmaps.ppt (11 slides)

F) Age Determination of Pacific Cod (*Gadus macrocephalus*) at the Alaska Fisheries Science Center – Delsa Anderl (Pcod_CIE_2011_2.ppt, 15 slides)

G) Preliminary Age Validation of Pacific Cod (*Gadus macrocephalus*) using Stable Oxygen Isotopes ($d^{18}O$) – Craig Kastelle (Kastelle.ppt, 17 slides)

H) Some Management Considerations Regarding Pacific Cod Stock Assessments – Jane DiCosimo (Pcod_CIEreviewF.ppt, 3 slides)

I) Landscape genetics of Pacific cod in the Aleutian Islands and Bering Sea – Ingrid Spies (Spies_CIE_talk.ppt, 29 slides)

J) Management strategy evaluation of the GOA Pacific cod fishery – Teresa A'mar (GOA Pacific cod MSE.pdf, 26 slides)

K) History of the EBS and GOA Pacific cod stock assessments – Grant Thompson (CIE assessment history.ppt, 100 slides

L) Overview of the final 2010 BSAI and GOA Pacific cod stock assessments and recent research – Grant Thompson (Current assessments and recent research.pptx, 58 slides)

Report provided for interest on final day of meeting

Evaluation and Analysis of Current Field Sampling in North Pacific Groundfish Fisheries. Task 1: Biological Sampling Protocols. Final Report, prepared by MRAG Americas Inc., Tampa, Florida for National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, Washington, April 2003.

Further background reading material:

Barbeaux, S.J, Gaichas J, Ianelli, J, Dorn, M. 2005 Evaluation of biological sampling protocols for at sea groundfish observers in Alaska.

J. Cahalan, J. Mondragon, and J. Gasper 2010. Catch Sampling and Estimation in the Federal Groundfish Fisheries of Alaska, 51 p.

Lauth, R. R. 2010. Results of the 2009 eastern Bering Sea continental shelf bottom trawl survey of groundfish and invertebrate resources, 228 p.

Olav A. Ormseth, Mike Canino, Liz Conners, Sandi Neidetcher, Peter Munro, Sarah Gaichas and Kerim Aydin (Alaska Fisheries Science Center); Doug Kinzey (University of Washington) September 2008. Summary of biological information regarding differences between Pacific cod in the eastern Bering Sea and Aleutian Islands, 26 p.

Craig R. Kastelle, Thomas E. Helser, Dan G. Nichol, Delsa M. Anderl, and Jennifer McKay September 2010. A Preliminary Age Validation of Pacific Cod (Gadus macrocephalus) Using Stable

Oxygen Isotopes (ä 18O), 17 p.
Gary Stauffer (Compiler) March 2003. NOAA Protocols for Groundfish Bottom Trawl Surveys of the Nation's Fishery Resources, 211 p.

Daniel G. Nichol, Taina Honkalehto, Grant G. Thompson 2007. Proximity of Pacific cod to the sea floor: Using archival tags to estimate fish availability to research bottom trawls, 7 p.

Appendix 2: The CIE Statement of Work

Attachment A: Statement of Work for Dr. Chris Darby (CEFAS)

External Independent Peer Review by the Center for Independent Experts

BSAI and GOA Pacific Cod Stock Assessment Review

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance with the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: The Alaska Fisheries Science Center (AFSC) requests a Center of Independent Experts (CIE) review of stock assessments for the Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA) Pacific cod stock assessments. The Pacific cod fisheries are large and Pacific cod is a key component of the BSAI and GOA ecosystems. The Pacific cod stock assessments routinely undergo thorough review by the AFSC, the North Pacific Fisheries Management Council's Groundfish Plan Teams and Scientific and Statistical Committee, and members of the public. The annual process for producing the Pacific cod stock assessments includes calls for new model proposals and two fully reviewed drafts of the stock assessment report. However, the Pacific cod stock assessments have not had the benefit of a CIE review since 2001. Therefore, a CIE review in 2011 would be timely. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall have expertise and working knowledge in the application of current stock assessment, including population dynamics, survey methodology, estimation of parameters in complex nonlinear models, and the Stock Synthesis assessment program in particular. CIE reviewers shall have recent experience conducting stock assessments for fisheries management. Each CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled at Alaska Fisheries Science Center in Seattle, Washington during the tentative dates of March 14-18, 2011.

Statement of Tasks: Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COTR, who forwards this information to the NMFS Project Contact no later than the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/sponsor.html).

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs can not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Participate during the panel review meeting at the Alaska Fisheries Science Center in Seattle, Washington during the tentative dates of March 14-18, 2011.

3) Conduct an independent peer review in accordance with the ToRs (**Annex 2**), during the tentative dates of March 14-18, 2011 at the Alaska Fisheries Science Center in Seattle, Washington, as specified herein.
4) No later than 1 April 2011, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and Dr. David Die, CIE Regional Coordinator, via email to ddie@rsmas.miami.edu. Each CIE report shall be written using the format and content requirements specified in **Annex 1**, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

7 February 2011	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
28 February 2011	NMFS Project Contact sends the CIE Reviewers the pre-review documents
14-18 March 2011	Each reviewer participates and conducts an independent peer review during the panel review meeting
1 April 2011	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
15 April 2011	CIE submits CIE independent peer review reports to the COTR
22 April 2011	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: Requests to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) each CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) each CIE report shall address each ToR as specified in **Annex 2**,
(3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

William Michaels, Contracting Officer's Technical Representative (COTR)
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-713-2363 ext 136

Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
10600 SW 131st Court, Miami, FL 33186
shivlanim@bellsouth.net Phone: 305-383-4229

Key Personnel:

NMFS Project Contact:

Grant Thompson
7600 Sand Point Way NE., Seattle, WA 98115-6349
Grant.Thompson@noaa.gov Phone: 541-737-9318

Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

   a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a brief summary of findings, of the science, conclusions, and recommendations.

   b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the Summary Report that they feel might require further clarification.

   d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   e. The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work
   Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Tentative Terms of Reference for the Peer Review

BSAI and GOA Pacific Cod Stock Assessment Review

Annex 2: Terms of Reference

For both the BSAI and GOA Pacific cod assessments, CIE reviewers shall evaluate current model assumptions and make recommendations for improvements thereof, including:

1. Use of age data, including:
    a. Use of age composition data
    b. Use of mean-size-at-age data
    c. Use of ageing bias as an estimated parameter
    d. External estimation of between-individual variability in size at age
2. Data partitioning/binning, including:
    a. Catch data partitioned by year, season, and gear
    b. Size composition data partitioned by year, season, gear, and 1-cm size intervals
    c. Age composition data partitioned by year, season, and gear
3. Functional form of the length-at-age relationship and estimating the parameters thereof
4. Number and functional form of selectivity curves estimated, including assumptions regarding which selectivity curves should be forced to exhibit asymptotic behavior
5. Fixing the trawl survey catchability coefficient for the recent portion of the time series such that the average product of catchability and selectivity across the 60-81 cm size range equals the point estimate obtained by Nichol et al. (2007)
6. Fixing the natural mortality rate at the value corresponding to Jensen's (1996) Equation 7
7. Input sample sizes for size composition and age composition data, and input log-scale standard deviations for survey abundance data
8. Allowing for annual variability in trawl survey selectivity
9. Setting the input standard deviation of log-scale recruitment (σ_R) equal to the standard deviation of the estimated log-scale recruitment deviations
10. Use of survey data and non-use of fishery CPUE data in model fitting

References:

Jensen, A. L. 1996. Beverton and Holt life history invariants result from optimal trade-off of reproduction and survival. *Can. J. Fish. Aquat. Sci.* 53:820-822.

Nichol, D. G., T. Honkalehto, and G. G. Thompson. 2007. Proximity of Pacific cod to the sea floor: Using archival tags to estimate fish availability to research bottom trawls. *Fisheries Research* 86:129-135.

Annex 3: Tentative Agenda

CIE Review of EBS and GOA Pacific cod stock assessment models

Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115
Building 4, Room xxx
March 14-18 2011

Review panel chair: Anne Hollowed, Anne.Hollowed@noaa.gov
Senior assessment author: Grant Thompson, Grant.Thompson@noaa.gov
Security and check-in: Julie Pearce, Julie.Pearce@noaa.gov (206)526-6547

Sessions will run from 9 a.m. to 5 p.m. each day, with time for lunch and breaks.

Monday, March 14th

1. Preliminaries
    a. Introductions
    b. Adopt agenda
    c. Description of the Pacific cod fisheries
2. Data
    a. Fishery-dependent data
        i. Catch data
        ii. Length composition data
    b. Fishery-independent data
        iii. Relative abundance data
        iv. Age composition and mean-length-at-age data
3. Assessment history

Tuesday, March 15th

4. Current assessments and possible future directions
5. Discussion
6. Assignments for models to be presented on Wednesday

Wednesday, March 16th

7. Review of models assigned on Tuesday
8. Discussion
9. Assignments for models to be presented on Thursday

Thursday, March 17th

10. Review of models assigned on Wednesday
11. Discussion
12. Review of models to be presented on Friday

Friday, March 18th

13. Review of models assigned on Thursday
14. Discussion
15. Report writing

Appendix 3: The Agreed CIE Review Agenda

CIE Review of the EBS and GOA Pacific cod stock assessment models

Alaska Fisheries Science Center
7600 Sand Point Way NE, Seattle, WA 98115
March 14-18, 2011
Building 4; Room 2076 (March 14-15), Room 2143 (March 16-18)

Review panel chair: Anne Hollowed, Anne.Hollowed@noaa.gov
Senior assessment author: Grant Thompson, Grant.Thompson@noaa.gov
Security and check-in: Julie Pearce, Julie.Pearce@noaa.gov (206)526-6547

Sessions will run from 9 a.m. to 5 p.m. each day, with time for lunch and morning and afternoon breaks.

Discussion will be open to everyone, with priority given to the panel and senior assessment author.

Monday, March 14th

Preliminaries:
9:00 Introductions—Anne
9:10 Adopt agenda—Anne
9:20 Description of the Pacific cod fisheries—Grant

Data:
9:40 Catch data—Jennifer Mondragon (via WebEx)
10:20 Fishery-dependent length composition data—Patti Nelson
a. 10:50 Break
Data, continued:
11:10 EBS trawl survey—Bob Lauth
11:40 GOA trawl survey—Mark Wilkins

12:10 Lunch

Data, continued:
1:10 Age composition and mean-length-at-age data—Delsa Anderl and Craig Kastelle

2:10 Assessment history—Grant
3:10 Break
3:30 Management issues related to the stock assessments—Jane DiCosimo

Possible considerations for future assessments:
b. 4:00 Genetic and spatial considerations—Ingrid Spies
4:30 Management strategy evaluation of the GOA stock—Teresa A'mar

Tuesday, March 15th

Details of last year's assessments and pre-meeting model runs—Grant
Discussion, real-time model runs—Everyone
Assignments for models to be presented on Wednesday—Panel

Wednesday-Thursday, March 16th-17th

Review of models assigned the previous day—Grant
Discussion, real-time model runs—Everyone
Assignments for models to be presented the following day—Panel

Friday, March 18th

Review of models assigned on Thursday—Grant
Discussion, real-time model runs—Everyone
Report writing—Panel

Appendix 4: Participant list to the CIE Review of the EBS and GOA Pacific cod stock assessment models for the Alaska Fisheries Science Center (AFSC)

CIE reviewers

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